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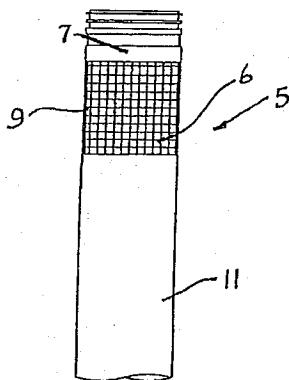
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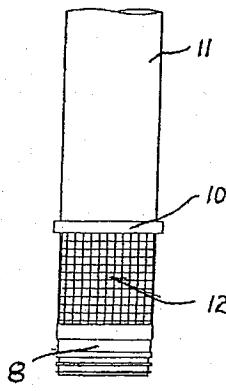
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*[Continued on next page]*

(54) Title: AERATION METHOD



(57) Abstract: A method and filtration module (5) for providing gas bubbles within an array of vertically disposed porous hollow membranes (6) to clean the outer surfaces of said membranes (6) when the array is immersed in a liquid by feeding (10) the gas bubbles into the array transversely of the vertical axis of the array. In one preferred form, the gas bubbles are retained within the array using a sleeve (11) surrounding the array (6) at least along part of its length.



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*ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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## TECHNICAL FIELD

The present invention relates to membrane filtration systems and more particularly to an improved backwash method and apparatus.

## BACKGROUND OF THE INVENTION

5 The use of membrane filtration systems is growing rapidly. The success of such systems is largely dependent on employing effective and efficient membrane cleaning methods. Commonly used physical cleaning methods include backwash (backpulse, backflush) using liquid permeate or a gas, and membrane scrubbing or scouring using a gas in the form of bubbles in a liquid. Examples of this second type of method are 10 illustrated in United States Patent No. 5,192,456 to Ishida et al, United States Patent No. 5,248,424 to Cote et al, United States Patent No. 5,639,373 to Henshaw et al, United States Patent No. 5,783,083 to Henshaw et al and our PCT Application Nos WO98/28066 and WO00/18498.

15 These prior art systems use a variety of techniques to introduce gas bubbles into the membrane arrays to produce effective and efficient surface cleaning. It has been found that effective cleaning is achieved by introducing bubbles into the array in a uniform manner and retaining the bubbles within the array as much as possible to produce efficient cleaning of the membrane surfaces.

## SUMMARY OF THE INVENTION

20 One object of the present invention is to provide an improved method and apparatus for introducing gas into a membrane array which overcomes or at least ameliorates one or more of the disadvantages of the prior art or at least provides a useful alternative.

25 According to a first aspect, the present invention provides a method of providing gas bubbles within an array of vertically disposed porous hollow membranes to clean the outer surfaces of said membranes when said array is immersed in a liquid, the method comprising the steps of feeding gas bubbles into said array transversely of the vertical axis of said array.

30 Preferably, said method includes the step of retaining said gas bubbles within said array using a sleeve surrounding said array at least along part of its length..

According to a further aspect, the present invention provides a membrane filtration module including a plurality of vertically disposed porous hollow membranes

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adapted, in use, to be immersed in a liquid, gas feeding means adapted to feed gas bubbles into said array transversely of the vertical axis of said array.

For preference, said module further includes a sleeve surrounding said array at least along part of its length for retaining said gas bubbles within the array. Preferably, 5 the sleeve extends along 17% or greater of the length of the array.

Preferably, said porous hollow membranes comprise hollow fibre membranes. For preference, the fibre membranes are formed in a generally cylindrical bundle. For further preference, said sleeve is located adjacent and above the gas feeding means. Preferably, the gas feeding means comprises a tube adapted to extend around the 10 periphery of the array of membranes, the tube having a plurality of openings located on its inner surface adjacent the array of membranes for feeding gas into the membrane array. For preference, a number of gas feeding means are provided along the length of the array or bundle. Preferably, the openings in the tube include extensions in the form of tubes adapted to extend into the array. For preference, the sleeve extends along a 15 major portion of the length of said membranes.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a broken side elevation view of a hollow fibre membrane module 20 with a gas feeding ring according to an embodiment of the invention;

Figure 2 shows a perspective view of the gas feeding ring of Figure 1;

Figure 3 shows a cutaway perspective view of the gas feeding ring of Figure 2; and

Figure 4 shows a graph of transmembrane pressure (TMP) vs time running of a filtration module for different percentage lengths of the wrapping of the module.

#### 25 DESCRIPTION OF PREFERRED EMBODIMENT

The preferred embodiment relates to porous hollow fibre membranes, however, it will be appreciated that the invention is not limited to such an application and is equally applicable to other similar arrays of membranes.

Referring to the drawings, a fibre membrane module 5 is shown in figure 1 30 comprising a bundle of hollow fibre membranes 6 extending between an upper and lower potting sleeves 7 and 8, respectively. The fibre membranes 6 are supported by a screen 9 also extending between the sleeves 7 and 8.

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The gas feeding ring 10 is fitted around the circumference of the fibre bundle 6 at a location spaced from the lower potting sleeve 8. A tube or sleeve 11 is placed around the bundle 6 above the gas feeding ring 10 and extends along the length of the bundle 6. The tube 11 may be formed as a solid tube or by wrapping a suitable sheet material

5 around the fibre bundle 6. The tube material should be impervious to the gas bubbles so they are retained within the fibre bundle but need not be liquid impervious. A region 12 above and below the potting sleeves is left uncovered by the tube 11 to allow entry of feed to the fibre membranes as well as removal of material backwashed from the membranes by usual processes as well as bubbles fed into the bundle by the gas feeding

10 ring 10.

Figures 2 and 3 show the gas feeding ring 10 in more detail. The ring is an annular tube 15 having spaced holes or openings 16 formed around its inner circumference to allow gas to be fed into the fibre array when the ring is placed around the bundle as shown in Figure 1. Gas or air may be supplied to the ring 10 through a port 17 in one

15 side of the ring.

The system provides a number of advantages. Air or gas can be fed into the membrane bundle at a number of locations along its length by use of a number of gas feeding rings. This enables more uniform provision of gas scouring bubbles within the bundles. Retention of bubbles within the bundle by the tube or sleeve 11 produces a

20 more efficient scouring of the fibre surfaces. Provision of scouring bubbles in this way, independent of the fibre headers, allows filtrate to withdrawn from either of both ends of the fibre module and allows reverse filtration from either or both ends of the fibre module when backwashing. Figure 4 illustrates the reduction in increase of TMP with increased sleeve or wrapping length along the fibre bundle.

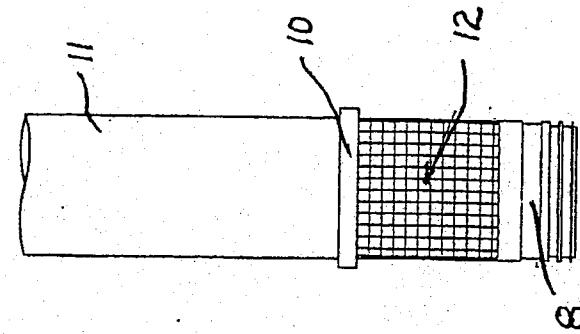
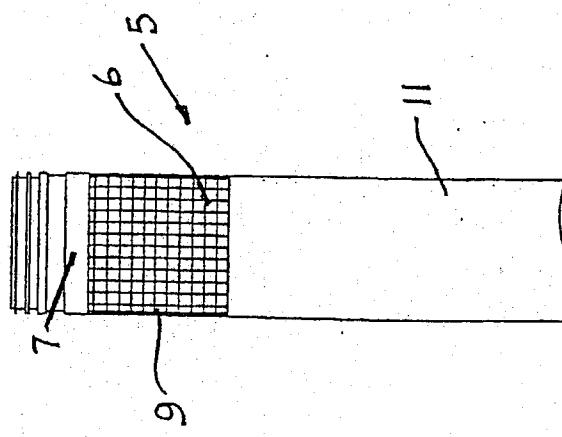
25 It will also be appreciated that further embodiments and exemplifications of the invention are possible without departing from the spirit or scope of the invention described.

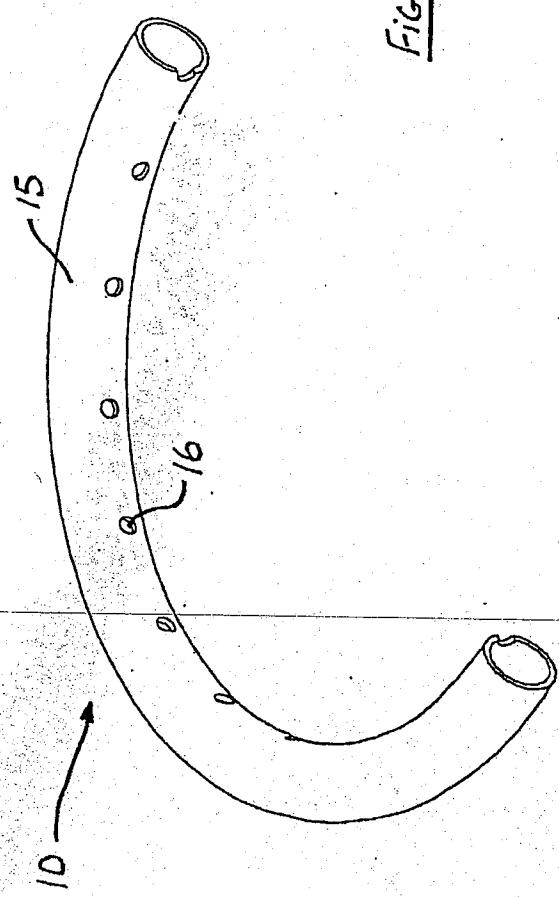
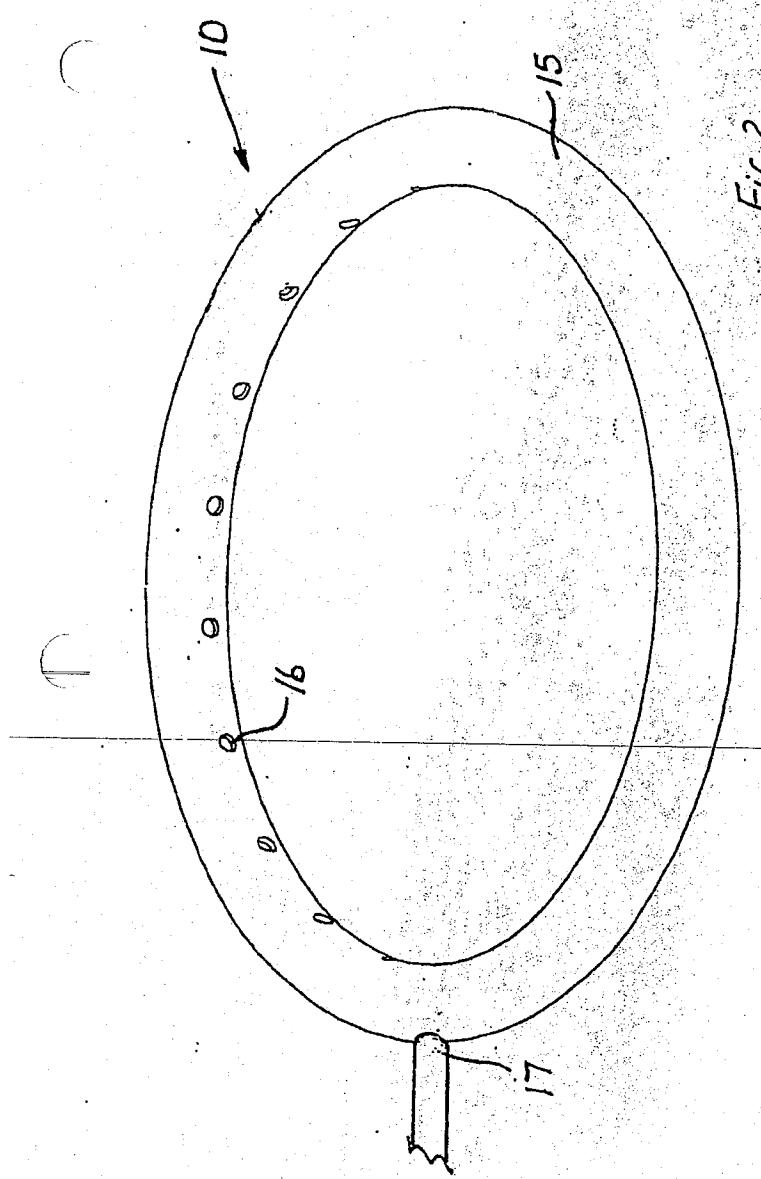
## CLAIMS:

1. A method of providing gas bubbles within an array of vertically disposed porous hollow membranes to clean the outer surfaces of said membranes when said array is immersed in a liquid, the method comprising the steps of feeding gas bubbles into said array transversely of the vertical axis of said array.
2. A method of providing gas bubbles within an array of vertically disposed porous hollow membranes according to claim 1 wherein said method includes the step of retaining said gas bubbles within said array using a sleeve surrounding said array at least along part of its length.
- 10 3. A membrane filtration module including a plurality of vertically disposed porous hollow membranes adapted, in use, to be immersed in a liquid, gas feeding means adapted to feed gas bubbles into said array transversely of the vertical axis of said array.
4. A membrane filtration module according to claim 3 wherein said module further includes a sleeve surrounding said array at least along part of its length for retaining said gas bubbles within the array.
- 15 5. A membrane filtration module according to claim 4 wherein the sleeve extends along about 17% or greater of the length of the array.
6. A membrane filtration module according to claim 4 wherein the sleeve extends along a major portion of the length of said membranes.
- 20 7. A membrane filtration module according to any one of claims 4 to 6 wherein said sleeve is located adjacent and above the gas feeding means.
8. A membrane filtration module according to any one of claims 3 to 7 wherein said porous hollow membranes comprise hollow fibre membranes.
9. A membrane filtration module according to claim 8 wherein the fibre membranes 25 are formed in a generally cylindrical bundle.
10. A membrane filtration module according to any one of claims 3 to 9 wherein the gas feeding means comprises a tube adapted to extend around the periphery of the array of membranes, the tube having a plurality of openings located on its inner surface adjacent the array of membranes for feeding gas into the membrane array.
- 30 11. A membrane filtration module according to claim 10 wherein the openings in the tube include extensions in the form of tubes adapted to extend into the array.
12. A membrane filtration module according to any one of claims 3 to 11 wherein a number of gas feeding means are provided along the length of the array or bundle.

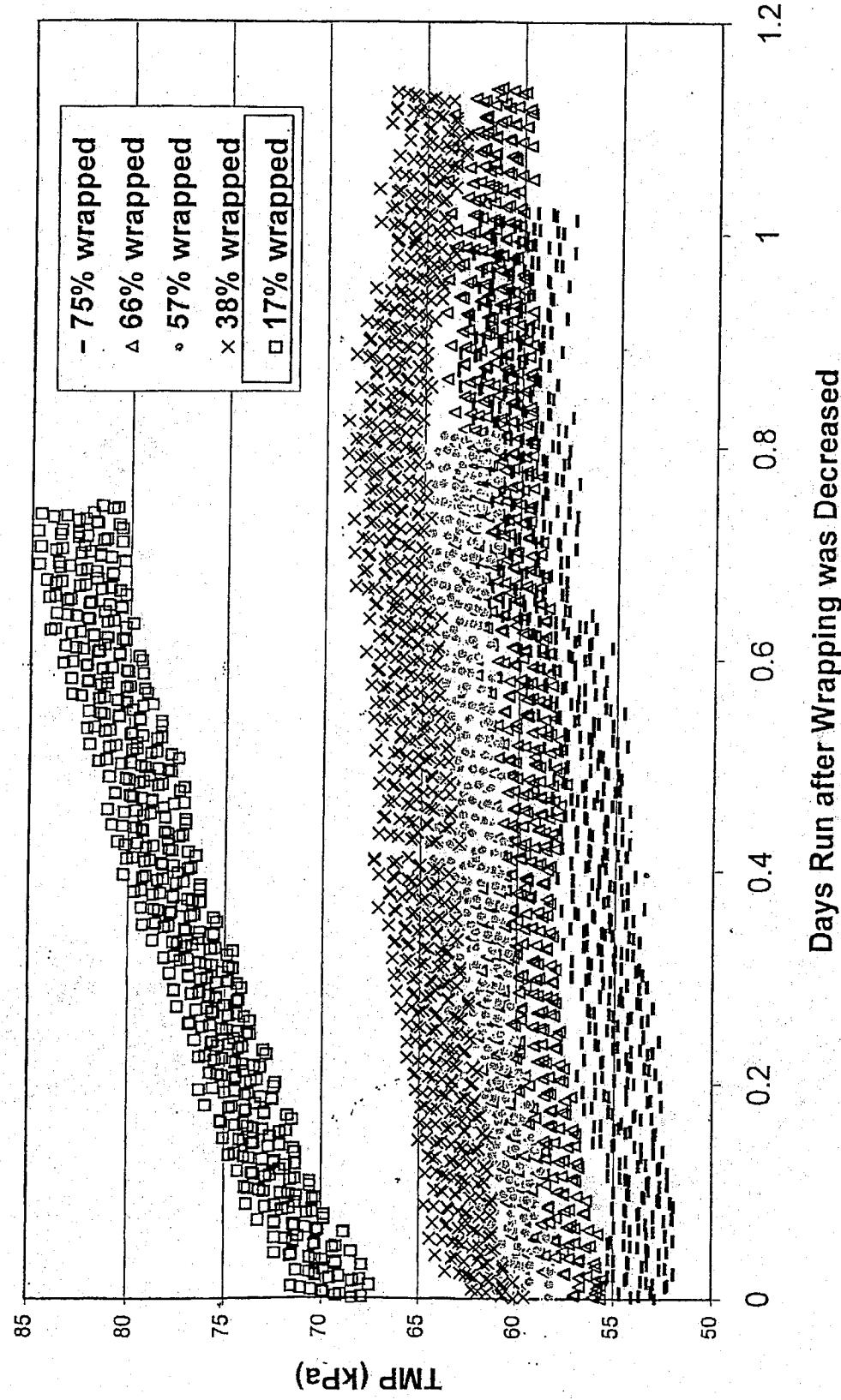
- 5 -

13. A membrane filtration module substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

Fig. 1



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Fig. 4

## INTERNATIONAL SEARCH REPORT

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b>																						
Int. Cl. 7: B01D 65/02, 65/08																						
According to International Patent Classification (IPC) or to both national classification and IPC																						
<b>B. FIELDS SEARCHED</b>																						
Minimum documentation searched (classification system followed by classification symbols) IPC B01D 65/02, 65/08																						
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																						
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI IPC + KEYWORDS (bubble)																						
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																				
X	US 4876006 A (OHKUBO et al.) 24 October 1989 See figure 8 and column 5 lines 21-37	1-9, 12																				
Y		10-11																				
X	US 2002/0070157 A1 (YAMADA) 13 June 2002 See entire document	1, 3, 8-9, 12																				
Y		2, 4-7																				
X	Patent Abstract of Japan, JP 07-185268 A (TORAY IND INC) 25 July 1995 & JP 07-185268 A See abstract and figures	1, 3, 8-9, 12																				
Y		2, 4-7																				
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C		<input checked="" type="checkbox"/> See patent family annex																				
<p>* Special categories of cited documents:</p> <table> <tr> <td>"A"</td> <td>document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E"</td> <td>earlier application or patent but published on or after the international filing date</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td>"&amp;"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	"P"	document published prior to the international filing date but later than the priority date claimed		
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Name and mailing address of the ISA/AU  AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer  <b>R.P. ALLEN</b> Telephone No : (02) 6283 2134																					

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/01068

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstract of Japan, JP 2000-317276 A (ZENKEN KK) 21 November 2000 & JP 2000317276 A See abstract, figure 3 and paragraph 32	1, 3, 8-9, 12
Y	Patent Abstract of Japan, JP 07-236819 A (NOK CORP) 12 September 1995 & JP 07-236819 A See figure 9	2, 4-7
X	WO 98/28066 A (MEMTEC AMERICA CORPORATION) 2 July 1998	1, 3, 8-10
Y	See entire document	2, 4-7
Y	US 2001/0047962 A (ZHA et al.) 6 December 2001 See entire document	2, 4-7
Y	Derwent Abstract Accession No. 2001-194533/20, Class D15, JP 2001-009246 A (HITACHI PLANT ENG & CONSTR CO LTD) 16 January 2001 See abstract	2, 4-7

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU03/01068

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	4876006	JP	62083005	JP	62097608		
US	2002070157	CN	1344582	EP	1180391	JP	2002058968
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JP	2000317276						
JP	7236819						
WO	9828066	AU	53957/98	CN	1244814	EP	0952885
		NZ	336455	NZ	510245	US	6555005
		US	2002195390	US	2003178365		
US	2001047962	AU	61834/99	CA	2342346	EP	1115474
		NZ	510394	US	2003075504	WO	0018498
JP	2001009246						

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